

CLAIMS:

1. A liquid electrophotographic toner composition comprising:
  - a) a liquid carrier having a Kauri-butanol number less than 30 mL; and
  - 5 b) a plurality of toner particles dispersed in the liquid carrier, wherein the toner particles comprise polymeric binder comprising at least one amphipathic copolymer comprising one or more S material portions and one or more D material portions, wherein the toner composition comprises hydrogen bonding functionality in an amount sufficient to provide a three dimensional gel of controlled rigidity which can be reversibly reduced
  - 10 to a fluid state by application of energy; and wherein the electrophotographic toner composition does not form a film under Photoreceptor Image Formation conditions.
2. The liquid electrophotographic toner composition according to claim 1, wherein the hydrogen bonding functionality comprises at least one self-associating, hydrogen
- 15 bonding functionality.
3. The liquid electrophotographic toner composition according to claim 1, wherein the hydrogen bonding functionality comprises a proton donor and an electron pair donor.
- 20 4. The liquid electrophotographic toner composition according to claim 3, wherein one of the proton donor or electron pair donor functionalities are located in the S material portion, and the corresponding proton donor or electron pair donor functionalities needed to form the donor pair is located in the D material portion.
- 25 5. The liquid electrophotographic toner composition according to claim 4, wherein the proton donor are located in the S material portion, and electron pair donor functionalities are located in the D material portion.
- 30 6. The liquid electrophotographic toner composition according to claim 4, wherein the electron pair donor functionalities are located in the S material portion, and proton donor functionalities are located in the D material portion.

7. The liquid electrophotographic toner composition according to claim 1, wherein one of the proton donor or electron pair donor functionalities are located on a first amphipathic copolymer, and the corresponding proton donor or electron pair donor functionalities needed to form the donor pair is located on a second amphipathic copolymer.
8. The liquid electrophotographic toner composition according to claim 7, wherein the proton donor or electron pair donor functionalities located on the first amphipathic copolymer are located on the S material portion of the first copolymer, and the proton donor or electron pair donor functionalities located on the second amphipathic copolymer are located on the S material portion of the second copolymer.
9. The liquid electrophotographic toner composition according to claim 7, wherein the proton donor or electron pair donor functionalities located on the first amphipathic copolymer are located on the D material portion of the first copolymer, and the proton donor or electron pair donor functionalities located on the second amphipathic copolymer are located on the D material portion of the second copolymer.
10. The liquid electrophotographic toner composition according to claim 7, wherein the proton donor or electron pair donor functionalities located on the first amphipathic copolymer are located on the S material portion of the first copolymer, and the proton donor or electron pair donor functionalities located on the second amphipathic copolymer are located on the D material portion of the second copolymer.
11. The liquid electrophotographic toner composition according to claim 7, wherein the proton donor or electron pair donor functionalities located on the first amphipathic copolymer are located on both the S material portion and the D material portion of the first copolymer, and the proton donor or electron pair donor functionalities located on the second amphipathic copolymer are located on both the S material portion and the D material portion of the second copolymer.

12. The liquid electrophotographic toner composition according to claim 1, said composition comprising a polyfunctional bridging compound having at least two proton donor or electron pair donor functionalities to assist in gel formation.

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13. The liquid electrophotographic toner composition according to claim 1, wherein one of the proton donor or electron pair donor functionalities are located on an amphipathic copolymer, and the corresponding proton donor or electron pair donor functionalities needed to form the donor pair is located on a polyfunctional bridging compound.

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14. The liquid electrophotographic toner composition according to claim 13, wherein proton donor functionalities are located on the amphipathic copolymer, and at least two electron pair donor functionalities are located on a polyfunctional bridging compound.

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15. The liquid electrophotographic toner composition according to claim 13, wherein electron pair donor functionalities are located on the amphipathic copolymer, and at least two proton donor functionalities are located on a polyfunctional bridging compound.

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16. The liquid electrophotographic toner composition according to claim 1, wherein proton donor functionalities are provided by incorporation of one or more proton donor-functional polymerizable compounds in the amphipathic copolymer, wherein the proton donor-functional polymerizable compound is selected from the group consisting of acrylic acid, methacrylic acid, 2-acrylamido-2-methyl propane sulfonic acid, allyl alcohol, allyl amine, allyl ethylamine, allyl hydroxyethyl ether, p-amino styrene, t-butylamino methacrylate, cinnamyl alcohol, crotonic acid, diallyl amine, 2,3-dihydroxy propyl acrylate, dipentaerythritol monohydroxypentaacrylate, 4-hydroxybutyl acrylate, 4-hydroxybutyl methacrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, 2-hydroxypropyl methacrylate, 4-hydroxy styrene, itaconic acid, maleic acid, methallylamine, pentaerythritol tetraacrylate, pentaerythritol triacrylate,

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polypropylene glycol monomethyl methacrylate, tris (2-hydroxyethyl)isocyanurate triacrylate, vinyl benzene alcohol, and 4-vinyl benzoic acid.

- 5 17. The liquid electrophotographic toner composition according to claim 1, wherein electron pair donor functionalities are provided by incorporation of one or more electron pair donor-functional polymerizable compounds in the amphipathic copolymer, wherein the electron pair donor-functional polymerizable compound is selected from the group consisting of allyl mercaptan, allyl dimethylamine, N-allyl piperidine, 1,3-butanediol
- 10 diacrylate, 1,4-butanediol diacrylate, 2-butoxyethyl acrylate, 2-butoxyethyl methacrylate, bis diallylamino methane, N,N-diallylmelamine, diethylaminoethyl acrylate, diethylaminoethyl methacrylate, diethylene glycol diacrylate, diethylene glycol dimethacrylate, 2-diisopropylamino ethyl methacrylate, 2-dimethylaminoethyl methacrylate, 2-dimethylamino methyl styrene, 3-dimethylamino neopentyl acrylate,
- 15 acrylamide, diacetone acrylamide, dimethylaminopropyl acrylamide, 2,3-epoxypropyl methacrylate (glycidyl methacrylate), 2-(2-ethoxyethoxy) ethyl acrylate, 2-(2-ethoxyethoxy) ethyl methacrylate, ethoxylated Bisphenol A diacrylate, ethoxylated trimethylol triacrylate, ethoxylated trimethylolpropane triacrylate, ethylene glycol dimethacrylate, glyceryl propoxy triacrylate, 1,6 hexanediol diacrylate, glycidyl
- 20 methacrylate, 1,6 hexanediol diacrylate, 1,6 hexanediol dimethacrylate, isobutyl vinyl ether, 2-methoxyethyl acrylate, neopentyl glycol diacrylate, neopentyl glycol dimethacrylate, pentaerythritol tetraacrylate, 2-phenoxyethyl acrylate, 2-phenoxyethyl methacrylate, polyethylene glycol diacrylate, polyethylene glycol dimethacrylate, propoxylated neopentyl glycol diacrylate, propoxylated neopentyl glycol dimethacrylate,
- 25 tetraethylene glycol diacrylate, tetraethylene glycol dimethacrylate, triethylene glycol diacrylate, triethylene glycol dimethacrylate, trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, tripropylene glycol diacrylate, tripropylene glycol dimethacrylate, vinyl benzene dimethylamine, 2-vinyl pyridine, 4-vinyl pyridine, and N-vinyl-2-pyrrolidone.

18. The liquid electrophotographic toner composition according to claim 1, wherein the D material portion of the amphipathic copolymer has a total calculated  $T_g$  greater than or equal to about 30°C.
- 5 19. The liquid electrophotographic toner composition according to claim 1, wherein the D material portion of the amphipathic copolymer has a total calculated  $T_g$  of from about 50-60°C.
20. The liquid electrophotographic toner composition according to claim 1, wherein  
10 the amphipathic copolymer has a total calculated  $T_g$  greater than or equal to about 30°C.
21. The liquid electrophotographic toner composition according to claim 1, wherein the amphipathic copolymer has a total calculated  $T_g$  greater than about 55°C.
- 15 22. The liquid electrophotographic toner composition according to claim 1, the toner particle comprising at least one visual enhancement additive.
23. A method of making a liquid electrophotographic toner composition, comprising the steps of:
- 20 a) providing a plurality of free radically polymerizable monomers, wherein at least one of the monomers comprises a first reactive functionality;
- b) free radically polymerizing the monomers in a solvent to form a first reactive functional polymer, wherein the monomers and the first reactive functional polymer are soluble in the solvent;
- 25 c) reacting a compound having a second reactive functionality that is reactive with the first reactive functionality and free radically polymerizable functionality with the first reactive functional polymer under conditions such that at least a portion of the second reactive functionality of the compound reacts with at least a portion of the first reactive functionality of the polymer to form one or more linkages by which the
- 30 compound is linked to the polymer, thereby providing an S material portion polymer with pendant free radically polymerizable functionality;

d) copolymerizing ingredients comprising (i) the S material portion polymer with pendant free radically polymerizable functionality, (ii) one or more free radically polymerizable monomers, and (iii) a liquid carrier in which polymeric material derived from ingredients comprising the one or more additional monomers of ingredient (ii) is insoluble;

said copolymerizing occurring under conditions effective to form an amphipathic copolymer having S and D portions and to incorporate proton donor or electron pair donor functionality in the copolymer, the toner composition comprising proton donor and electron pair donor functionality in an amount sufficient to provide a three dimensional gel of controlled rigidity which can be reversibly reduced to a fluid state by application of energy; and wherein the electrophotographic toner composition does not form a film under Photoreceptor Image Formation conditions.

24. The method of claim 23, wherein the first reactive functionality is selected from hydroxyl and amine functionalities, and the second reactive functionality is selected from isocyanate and epoxy functionalities.

25. The method of claim 23, wherein the first reactive functionality is a hydroxyl functionality, and the second reactive functionality is an isocyanate functionality.

26. The method of claim 23, wherein the first reactive functionality is selected from isocyanate and epoxy functionalities, and the second reactive functionality is selected from hydroxyl and amine functionalities.

27. A method of electrophotographically forming an image on a substrate surface comprising steps of:

- a) providing a liquid toner composition of claim 1;
- b) causing an image comprising the toner particles in a carrier liquid to be formed on a surface of a photoreceptor; and

c) transferring the image from the surface of the photoconductor to an intermediate transfer material or directly to a print medium without film formation on the photoreceptor.